University of Bahrain
College of Information technology
Department of Computer Engineering

Test (1)

Student Name	
I.D. No.	
Section	

Course Title: Digital Logic
Course number: ITCE 202/250
Semester: 1
Academic Year: 2012/2013
Duration : 1hour 30 minutes
Date: 14th November 2012

Read the following before you start:

1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only.

Question	Mark	Mark attained
1	25	
2	20	
3	25	
4	25	
Total	100	

Question [1]: [25 mark]

(a) Convert the following numbers showing all steps. [2 marks each]

$(100110)_{2\text{'s complement}} = (100101)_{1\text{'s complement}}$

$- \quad 1$

100101

$(A29)_{16} = (220221)_4$

$(1010\ 0010\ 1001)_2$

$(2\ 2\ 0\ 2\ 2\ 1)_4$

$(13)_{10} = (0100\ \ 0110)_{excess\_3}$

$(7)_{10} = (1000)_{7\text{-}3\text{-}2\text{-}1}$

$(+35)_{10} = (0100011)_{1\text{'s complement}}$

$(-66)_{10} = (10111110)_{2\text{'s complement}}$

(b) Add the following numbers in BCD [5 marks]

$(98)_{10}+(45)_{10}$=

	1001	1000	← ①
+	0100	0101	← ①
	1101	1101	← ①
+	0110	0110	← ①
(0001	0100	0011) BCD	← ①

c) What is the range of 2's complement numbers that can be represented in 8-bit word length. [3 marks]

$-2^{n-1} \rightarrow +2^{n-1}-1$

$-2^{7} \rightarrow 2^{7}-1$

d) Perform the following operation using 6-bit 2's complement numbers and indicate the case of an overflow. [5 marks]

$(-20)_{10}+(-15)_{10}$=

$(-20)_{10} = (110100)_2$ ① $\Rightarrow$

$(-15)_{10} = (101111)_2$ ①

$$\begin{array}{rcccccc} & 1 & 0 & 1 & 1 & 0 & 0 \\ + & 1 & 1 & 0 & 0 & 0 & 1 \\ \hline 1 & 0 & 1 & 1 & 1 & 0 & 1 \end{array}$$ ① ①

Overflow ①

Solution

Question [2]: [25 mark]

a- Use Boolean algebra to Simplify the following:

$$a\bar{b}\,c + \cancel{a\bar{d}c} + b\bar{d}c + \bar{b}c$$

c.t

(4)

$a\bar{b}\,c + b\bar{d}c + \bar{b}c$

$\bar{b}c(1+a) + b\bar{d}c$ (3)

$\bar{b}c + b\bar{d}c = c(\bar{b} + b\bar{d}) = c(\bar{b} + \bar{d}) = c\bar{b} + c\bar{d}$

(2) (3)

b- Use Demorgan then simplify the following:

$$\overline{xy \cdot (x \oplus y) \cdot \overline{(\bar{x} + \bar{y})}}$$

(3)

$\overline{xy} + \overline{(x \oplus y)} + (\bar{x} + \bar{y})$

(4)

$\bar{x} + \bar{y} + xy + \bar{x}\bar{y} + \bar{x} + \bar{y}$

$\bar{x} + \bar{y} + xy + \bar{x}\bar{y}$ (2)

(4)

$\bar{x}(1+\bar{y}) + \bar{y} + xy =$

$\bar{x} + \bar{y} + xy = \underbrace{\bar{x} + \bar{y} + x}_{(2)} = \underbrace{1 + \bar{y}}_{(2)} = 1$

Question [3]: [25 mark]

Design a combinational circuit with three inputs, x, y, and z (x being the MSB), and three outputs, A, B, and C (A being the MSB). When the binary input (xyz) is 3, 4, 5, 6, or 7, the binary output (A B C) is one less than the input. When the binary input is 0, 1, or 2, the binary output is two greater than the input.

For the above problem do the following;

a. Construct the truth table of the system.

n	x	y	z	A	B	C
0	0	0	0	0	1	0
1	0	0	1	0	1	1
2	0	1	0	1	0	0
3	0	1	1	0	1	0
4	1	0	0	0	1	1
5	1	0	1	1	0	0
6	1	1	0	1	0	1
7	1	1	1	1	1	0
		3			3	

b. Find the Minterm expansion of output A in decimal notation.

$$\underbrace{A = \Sigma m}_{3} \underbrace{(2, 5, 6, 7)}_{3}$$

if algebraic given 3

c. Find the Maxterm expansion of output C in decimal notation.

$$\underbrace{C = \Pi M}_{3} \underbrace{(0, 2, 3, 5, 7)}_{3}$$

if algebraic given 3

d. Find the minimum sum of products for output B, and draw the circuit using at least one XOR as well as other gates.

$= \Sigma m(0,1,3,4,7)$

$\Pi M(2,5,6)$

yz \ x	0	1
00	1	1
01	1	0
11	1	1
10	0	0

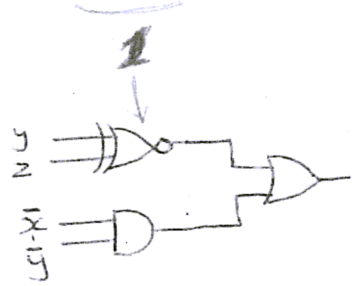
3

Kmap
1's
0's
Groups x3

$B = \bar{y}\bar{z} + yz + \bar{x}\bar{y}$ or $B = \bar{y}\bar{z} + yz + \bar{x}z$

3

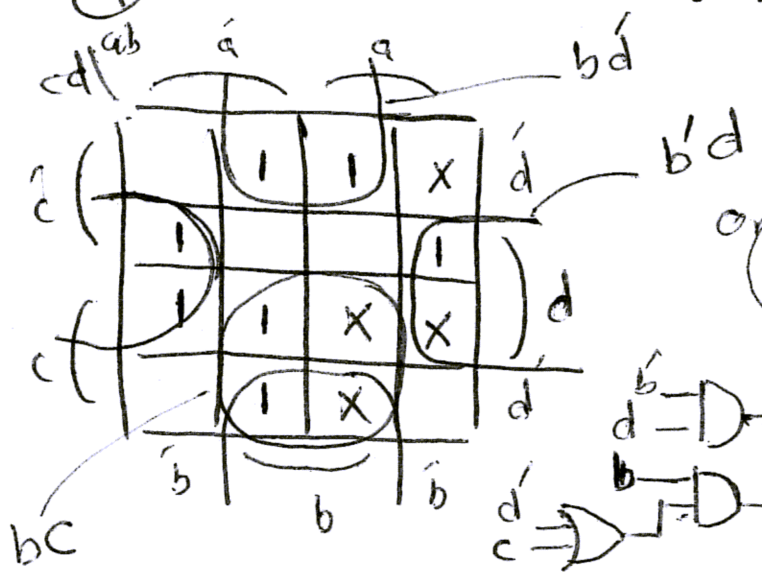
$= \underbrace{\overline{y \oplus z}}_{1} + \bar{x}\bar{y}$ or $B = \overline{y \oplus z} + \bar{x}z$



Question [4]: [25 mark]

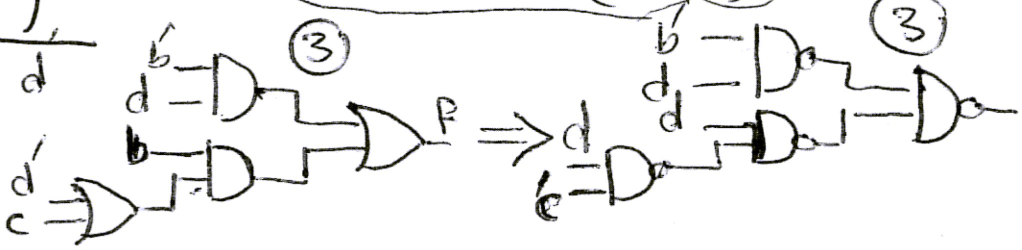
a) Realize the expression $F(a,b,c,d)=\sum m(1,3,4,6,7,9,12)+\sum d(8,11,14,15)$ with a minimum three-level circuit using only two input NAND gates. (13)

(4)

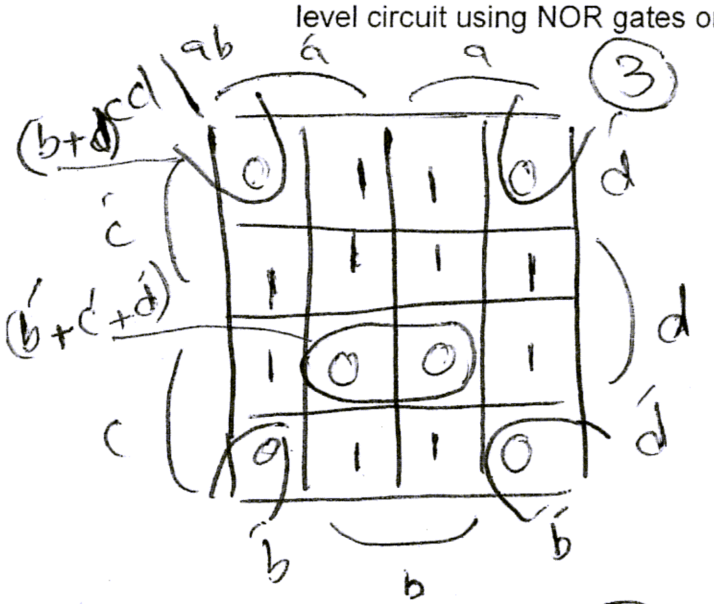


$$f(a,b,c,d) = b'd + bd' + bc$$
$$= b'd + b(d'+c) \quad (3)$$

or
$$f = bd' + b'd + cd$$
$$= bd' + d(b'+c)$$



b) Realize the expression $F(a,b,c,d)=bc'+a'b'd+bcd'+ab'd$ with a minimum two-level circuit using NOR gates only. (12)



$$f(a,b,c,d) = (b+d)(b'+c'+d') \quad (3)$$